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U1S S1990 S2002 S2013

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GB 0809443 A EP 0140506 A2 US 4388893 A

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(54) Positive displacement fuel delivery pump combined with vacuum pump

(57) A combined fuel delivery and vacuum pump for a motor vehicle comprises a delivery pump 3 with at least one pump chamber 23 in which two rotationally driven and mutually engaging gear wheels 25 are disposed to deliver fuel from an intake chamber (29, Fig 2) into a pressure chamber (31) which can be connected to an internal combustion engine. A further pump 5, which supplies air and whose intake side (65, Fig 4) is connected in use to a brake servo of the motor vehicle, is disposed in the same housing 1 as the delivery pump 3 in order to reduce the installation space required.

FIG. 1

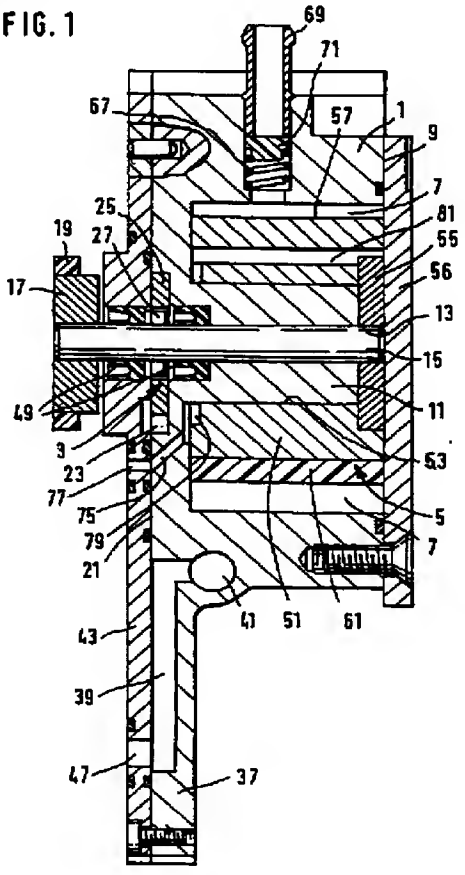

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FIG. 1

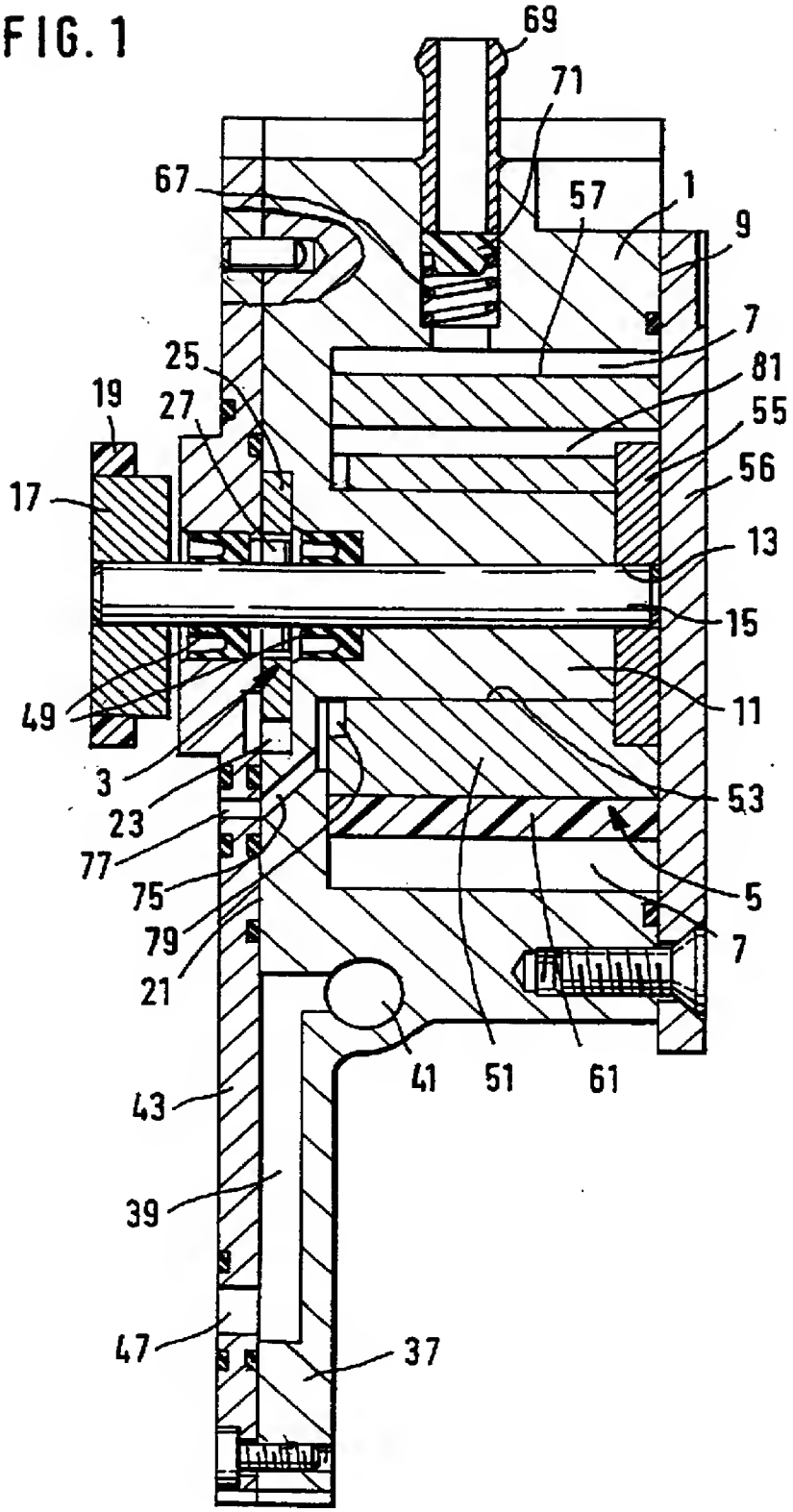
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FIG. 2

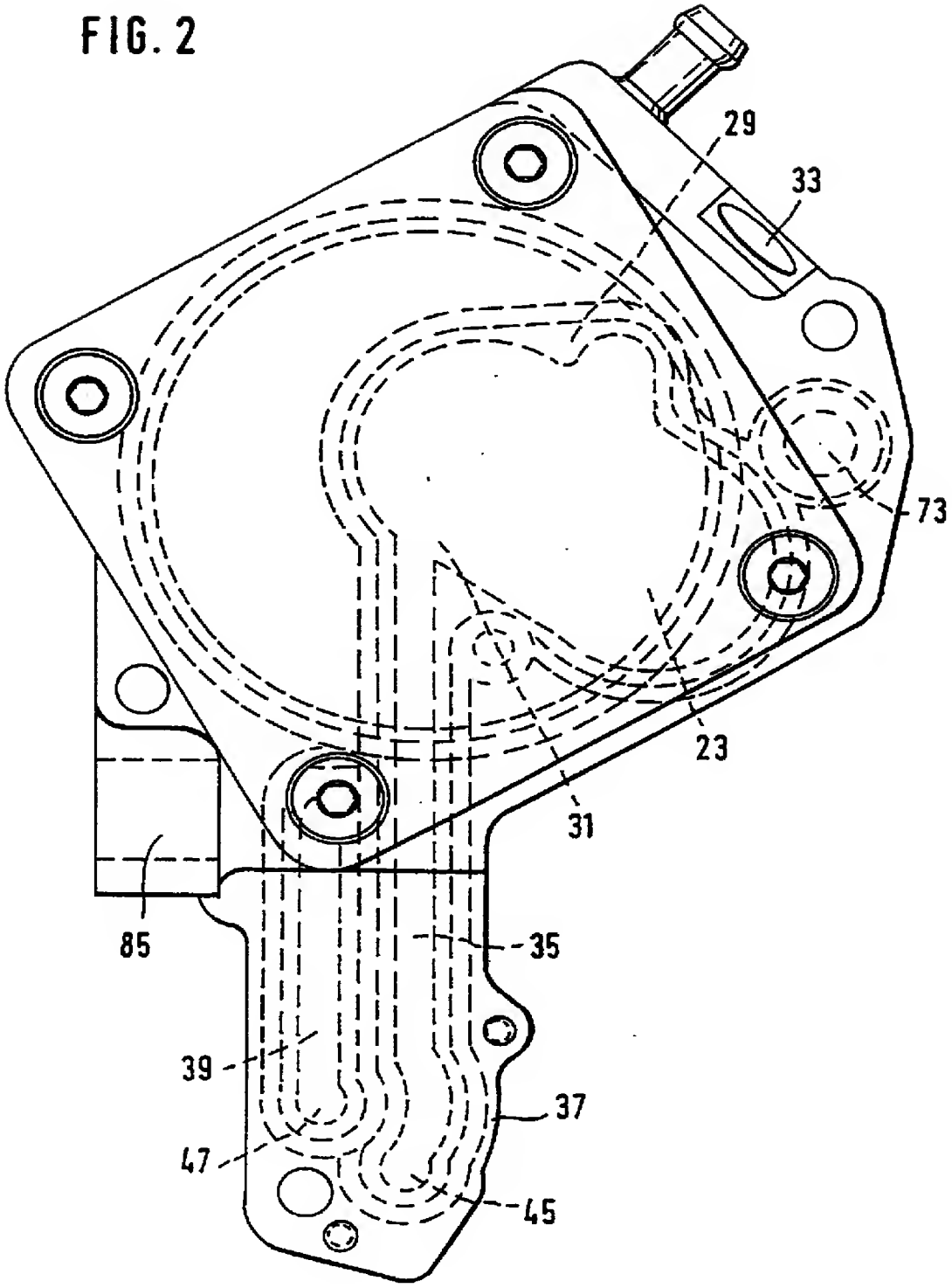

FIG. 3

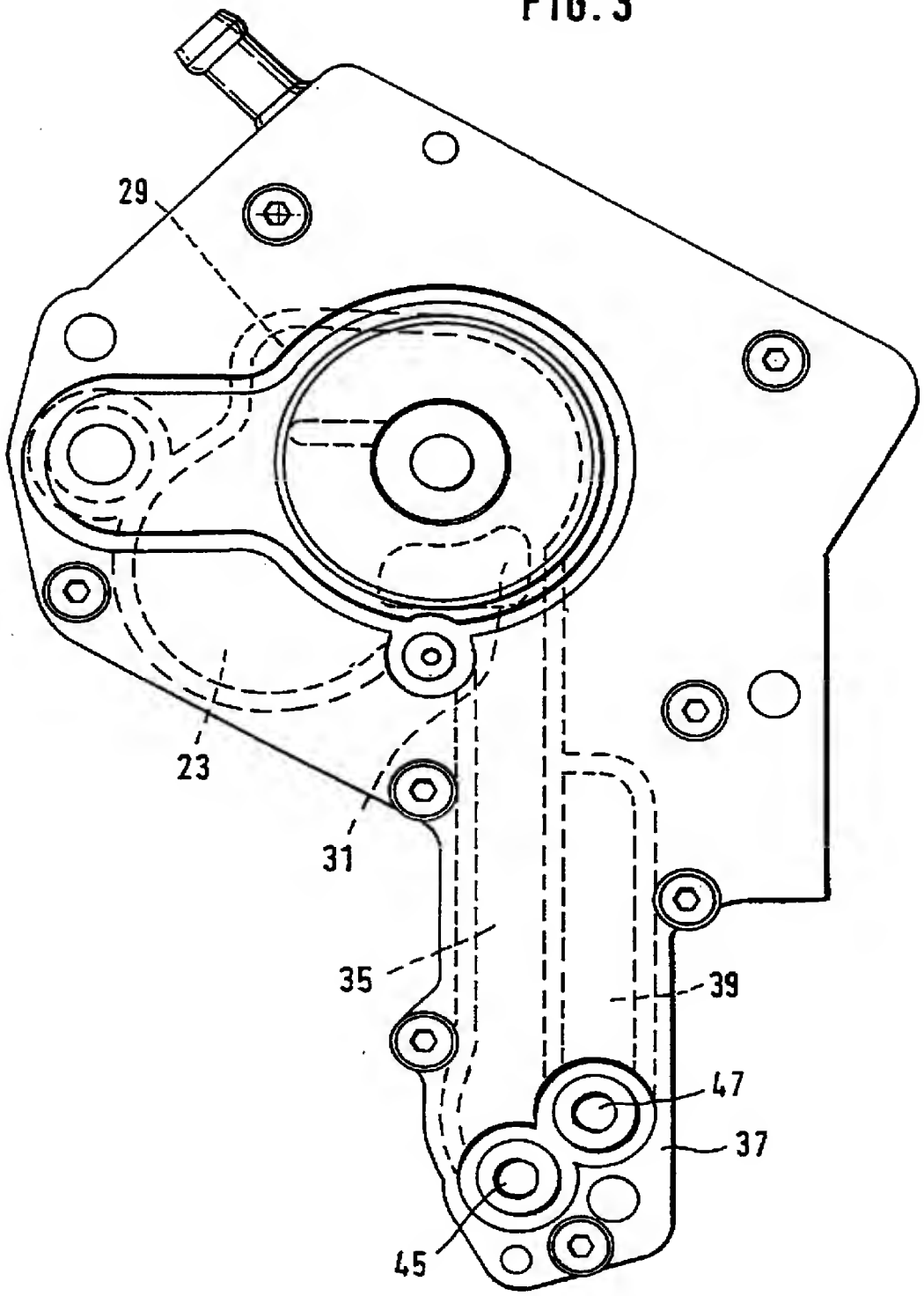

FIG. 4

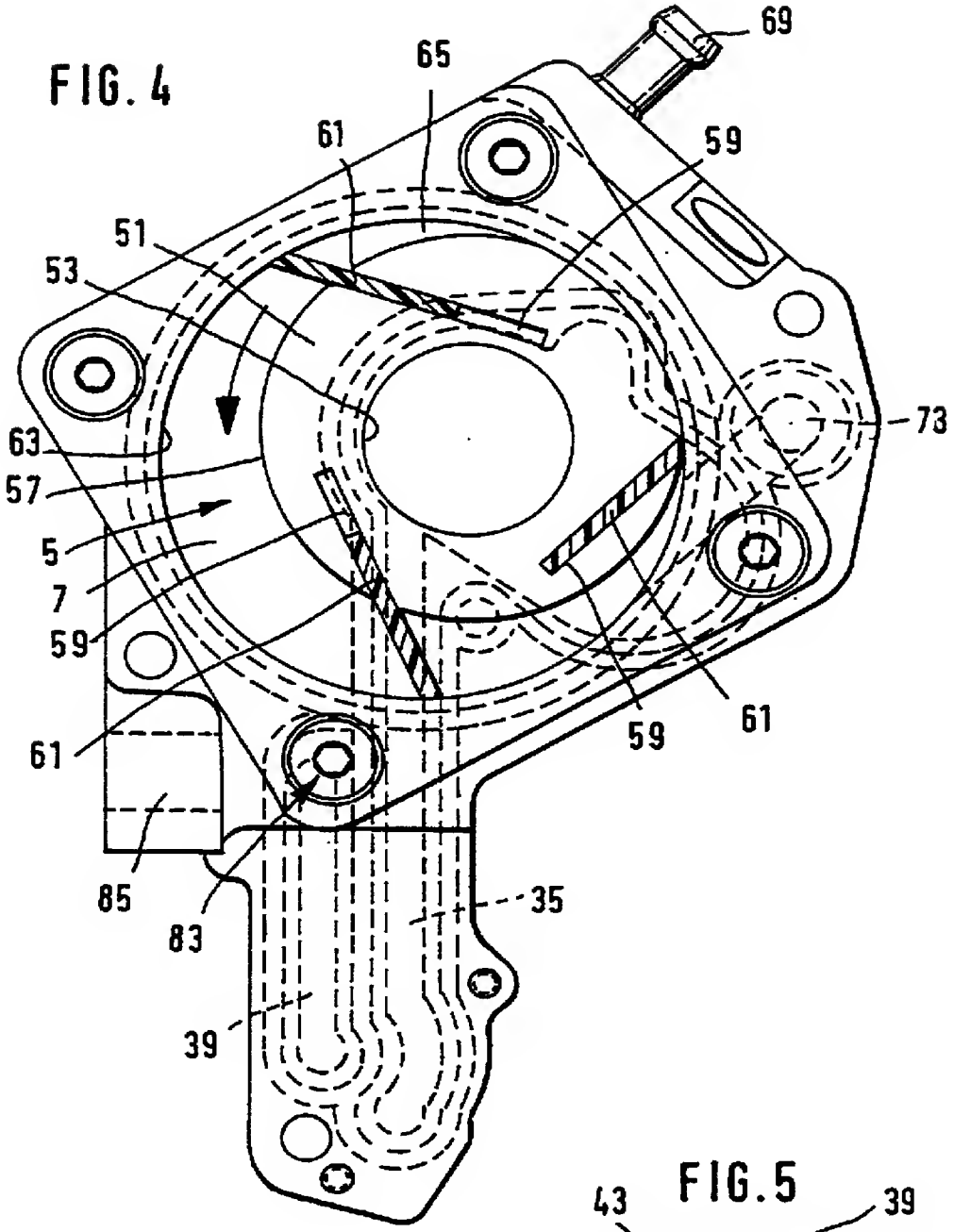
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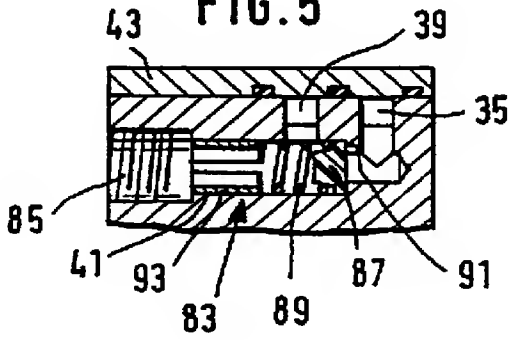
FIG. 5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DESCRIPTION

'DEVICE FOR THE DELIVERY OF FUEL FROM A STORAGE TANK TO AN INTERNAL COMBUSTION ENGINE OF A MOTOR VEHICLE'

Prior Art

The invention relates to a device for the delivery of fuel from a storage tank to an internal combustion engine of a motor vehicle according to the generic type of claim 1. Devices of this kind are formed in a known manner from a fuel delivery pump driven preferably by the internal combustion engine which draws fuel from a storage tank and delivers the said fuel to the internal combustion engine or a high pressure injection pump provided thereon.

DE 27 09 913 C2 discloses a gear delivery pump which is suitable for the delivery of fuel from a storage tank to an internal combustion engine which has in its housing a pump chamber in which two rotationally driven and mutually engaging gear wheels are arranged which convey a delivery medium (e.g. fuel) from an intake chamber along a delivery duct formed between the end face of the gear wheels and the wall of the pump chamber into a pressure chamber. Furthermore it is known for internal combustion engines in motor vehicles to provide on said engines a vacuum pump in order to produce a negative pressure for a brake servo of the motor vehicle. This vacuum pump is driven preferably by the internal combustion engine and is likewise fixed to said engine or to a high pressure pump. However, the disadvantage of these known systems is that they are designed as separate assemblies and therefore demand considerable installation space and are costly to manufacture.

Advantages of the Invention

In contrast thereto, the device according to the invention for the delivery of fuel from a storage tank to an internal combustion engine of a motor vehicle comprising the characterising features of claim 1 has the advantage that the required installation space can be reduced considerably by virtue of the structural unit of the pumps and the preferred manner of accommodating in a common pump housing the fuel delivery pump and the pump which acts as a vacuum pump and delivers air. Moreover the manufacturing costs and the weight of the pump unit are reduced overall as now only one common pump housing is required.

It is particularly advantageous to arrange the pump assemblies, which preferably are designed as gear and vane pumps, axially in series. In addition to minimising the size of the installation, this makes possible, in particular, the use of a single common drive shaft. This drive shaft then only requires a connection to the camshaft, which occurs in an advantageous manner by means of an elastic coupling member in the form of a groove-adjusting washer connection (elastic-adjusting washer) which compensates positional tolerances between the shaft ends and moreover facilitates an oscillating decoupling between the camshaft of the internal combustion engine and the drive shaft of the pumps, wherein the gear delivery pump works as a further hydraulic damping member between the rotor of the vane pump and the camshaft. Furthermore, the non-positive connection between the camshaft and the drive shaft is also effective as a predetermined breaking point in the event that one of the pumps suddenly becomes blocked or that the drive shaft locks, so that these are protected from mechanical damage.

The advantageous manner of mounting the drive shaft and the rotor

of the vane pump on a cylindrical cross-piece of the pump housing allows the drive shaft to transfer only the driving torque to the vane pump, but it does not support its transverse forces so that the drive shaft can correspondingly be of a slimmer design. In addition it is therefore possible in one process to machine the outer surface of the cylindrical housing cross-piece which acts as a sliding bearing for the rotor and the pump chamber wall of the vane pump serving as a running surface for the vane. This reduces the manufacturing costs and the positional tolerances which occur. The rotor of the vane pump and the housing can be designed as cast aluminium parts which in addition to the reduction in weight has the advantage that both components have the same thermal expansion coefficient and beads and bores provided in the housing can be formed concurrently with the casting process. For protection against wear the aluminium components can also be anodized. In order to provide a greater effective length, the wings guided in a displaceable manner in slots of the rotor are in addition disposed in an advantageous manner inclined towards a radial plane of the rotor. A further advantage is achieved by virtue of the design of the fuel and lubricating medium ducts within the pump housing in the form of beads and by closing the pump housing and therefore the pump chambers and ducts by means of a simple housing cover made out of sheet metal. It is particularly advantageous to flange mount the pump device directly onto the cylinder head of the internal combustion engine which is to be supplied in such a way that the connection bores for the fuel return line connection of the internal combustion engine and the fuel supply line connection (at the pressure side) towards the said internal combustion engine are directly adjacent to each other so that additional tube connections can be omitted. The fuel from the internal combustion

engine is returned to the storage tank by way of the delivery device. The pressure in the delivery device is controlled in a structurally convenient manner by virtue of a pressure limiting valve which is fitted into a transfer duct which issues into a return line between the pressure duct and the return duct.

The lubricant supply common to both pumps is connected to the lubricant circuit of the internal combustion engine by way of a connection bore in the pump housing. This lubricant bore in the housing is disposed in an inclined manner and offset with respect to the lubricant bore in the flange, in order to reduce the supply of lubricant. The lubricant reaches the end of the pump housing remote from the camshaft by way of beads in the slide bearing surfaces and/or a bore in the rotor through the pump chamber of the vane pump and there it exits again out of a bore into the lubricant circuit of the internal combustion engine.

A further advantage is achieved by means of the positive connection between the drive shaft and the driven wheel of the delivery pump which can be produced by means of a pin fitted into a transverse bore of the drive shaft, a positive coupling applied onto the drive shaft, a rolled or milled positive keying or a feather key.

In order to limit the fuel supply to the fuel delivery pump and thus the maximum delivery volume of the delivery pump, a restriction point, e.g. a narrowing in its intake pipe, can alternatively be provided, e.g. in the intake bore.

Furthermore, it is advantageous to provide grooves on the shaft seal rings on the drive shaft which separate the fuel and lubricant media. The said grooves are designed in such a manner that a pressure gradient occurs in the direction of the fuel side. The result of this is that in the event of

possible leakages on the shaft seal rings only lubricant can reach the fuel system, but no fuel passes into the lubricating oil circuit which would otherwise dilute the lubricant.

Further advantages and advantageous arrangements of the subject matter of the invention can be taken from the description, the drawing and the claims.

Drawing

An embodiment of the device in accordance with the invention for the delivery of fuel from a storage tank to an internal combustion engine of a motor vehicle is illustrated in the drawing and is further explained hereinunder.

Fig. 1 shows a sectional view through the delivery device, Figs. 2 and 3 show two lateral views of Fig. 1 with concealed course of the pump chamber of the gear pump and of the fuel ducts, Fig. 4 shows an illustration analogous to Fig. 2 in which the components of the vane pump are shown and Fig. 5 shows a detailed section of Fig. 4 which illustrates the pressure limiting valve fitted between the return duct and the pressure duct.

Description of the embodiment

The device illustrated in Figs. 1 to 4 and shown only with its components which are essential for the invention for the delivery of fuel from a storage tank (not illustrated) to an internal combustion engine (likewise not illustrated) of a motor vehicle or to the high pressure injection pump thereon comprises a pump housing 1 in which are fitted a fuel delivery pump designed as a gear pump 3 and a pump, which delivers air and is designed as a vane pump 5 (referred to hereinunder as a vacuum pump).

The delivery pump can as an alternative even be designed as a

different positive displacement pump, e.g. as a roller vane pump. The pump housing 1 has on the inside a circular recess which forms a pump chamber 7 of the vane pump 5 which is open towards an end face 9 of the pump housing 1 and which is limited radially inwards by means of a cylindrical housing cross-piece 11 which is disposed eccentrically to the pump chamber 7. An axial through-going bore 13 is provided in this housing cross-piece 11, in which a drive shaft 15 is rotatably guided, which drive shaft protrudes out of the pump housing 1 in the direction remote from the end face 9. A driving plate 17 is pressed on the free end of the drive shaft 15 which protrudes out of the pump housing 1 in the direction remote from the end face 9. A driving plate 17 is pressed on the free end of the drive shaft 15 which protrudes out of the pump housing 1, the said driving plate being provided with grooves for receiving an elastic coupling member in the form of a feather key 19. The ends of the feather key 19 which protrude from the driving plate 17 engage positively into corresponding recesses of a camshaft (not illustrated) of the internal combustion engine, the free shaft end of which being disposed in an aligned manner with respect to the drive shaft, so that the rotational movement of the camshaft is transmitted onto the drive shaft 15 by way of the elastic coupling member 19 and the driving plate 17.

The pump housing 1 comprises, on its second end face 21 which faces the driving plate 17, an oval recess which forms a pump chamber 23 of the gear wheel pump 3. This recess is separated from the pump chamber 7 by means of a partition in the housing and is penetrated by the drive shaft 15. A first gear wheel 25 of a gear wheel pair, which mutually engage on their end faces, on the drive shaft 15 within the pump chamber 23, is connected positively to the drive shaft 15 by means of a pin 27 pushed into

the drive shaft 15. The second gear wheel (not illustrated in detail) is disposed in the lateral view (Figs. 2,3) in an inclined manner offset with respect to the first gear wheel 25 wherein its axle is likewise mounted in the pump housing 1. As an alternative it is even possible to mount the second gear wheel by means of a cylindrical housing cross-piece instead of the shaft. An upper portion of the pump chamber 23 which is connected radially to the gear wheels at a height of the tooth engagement forms an intake chamber 29 and a lower portion of the pump chamber 23 which is opposite thereto on the gear wheel engagement forms a pressure chamber 31 of the gear wheel pump 3. An intake bore 33 in the pump housing, which is connected to a fuel line from the storage tank, issues into the intake chamber 29.

This intake bore 33 can even be provided with a reduction of area of cross section in order to limit the maximum flow rate by means of "intake restriction".

A pressure duct 35 which is formed by means of a bead in the end face 21 of the pump housing 1 and which extends into a cross-piece 37 of the pump housing 1, leads from the pressure chamber 31. A return duct 39 which likewise is formed by means of a bead is disposed in parallel with this pressure duct 35. The said return duct is connected by the pressure duct 35 by way of a connection bore 41 and leading from said connection bore extends approximately to the end of the pressure duct 35. The pump chamber 23, the pressure duct 35 and the return duct 39 are sealed on the side remote from the housing 1 by means of a first housing cover 43 screwed in a sealing manner onto the end face 21 of the pump housing 1, in which housing cover are disposed a pressure bore 45, which leads from the pressure duct 39, and a return bore 47, which leads from the return

duct 39. The housing cover 43 is for its part flange mounted in such a way onto the cylinder head of the internal combustion engine which is to be supplied, that the pressure bore 45 and the return bore 47 issue directly into corresponding fuel ducts in the cylinder head. In order to seal the pump chamber 23 of the gear wheel pump 3 against the internal combustion engine and the vane pump 5, in addition to various seal rings on the housing cover two shaft seal rings 49 are disposed on the drive shaft 15 and seal the pump chamber 23 onto the drive shaft 15.

The vane pump 5, illustrated in detail in Figs. 1 and 4 is formed from a cylindrical rotor 51, which is disposed in the pump chamber 7 and comprises an axial bore which is guided with its cylindrical inner wall surface 53 in the form of a slide bearing on the peripheral surface of the cylindrical housing cross-piece 11. The rotor 51 is connected positively to the drive shaft 15 by way of a coupling disc 55 pressed onto the end of the drive shaft 15 remote from the gear wheel pump 3, which drive shaft on the other hand is supported by a second housing cover 56 which seals the pump chamber 7 of the vane pump 5, the housing cover being screwed in a sealing manner on the end face 9 of the pump housing 1. In the cylindrical outer-wall surface 57 of the rotor 51 which limits the pump chamber 7 radially inwards, preferably three slots 59 are provided for receiving wings 61 in a displaceable manner, which slots are inclined in the direction of rotation of the rotor 51 from its radial plane. As this type of rotor 51 is disposed eccentrically in the pump chamber 7 such that the rotor lies partly with its external wall surface 57 against the radial pump chamber wall 63 of the pump chamber 7, the slots 59 are designed in such a way that they can receive fully the wings 61 and guide said wings in a satisfactory manner when said wings protrude outwards to the maximum extent, and form

sealing surfaces to the wings 61 in order to urge the wings 61 automatically radially outwards during the induction period in the event of pressure being exerted on the wing ends by means of the lubricating oil and thus improving the pressing-down force and sealing effect of the wings 61 on the housing 1 especially in the event of low rotational speeds.

An upper region of the pump chamber 7 forms in the event of rotation of the rotor 51 in an anti-clockwise direction (Fig. 4) an intake region 65 of the vane pump 5, into which intake region a connection bore 67 issues, in which connection bore a connecting piece 69 is fitted onto which connecting piece a hose line from a brake servo of a motor vehicle can be attached. In order to be able to create a vacuum in the break servo in the most effective way possible, a non-return valve 71 which opens in the direction of the pump chamber 7 is in addition connected in series within the bore 67 to the connecting piece 69.

Pressure is discharged from the vane pump 5 by means of an outlet bore 73 which leads from the region of the smallest cross-section of the pump chamber 7 of the vane pump 5 and is connected on the outlet side to a flange on the cylinder head, which flange is connected to the lubricant circuit of the internal combustion engine.

The lubrication of the vane pump 5 occurs by way of a lubricant bore 75 (illustrated in detail in Fig. 1) which is disposed in an inclined manner and is connected to the lubricant circuit of the internal combustion engine by way of a corresponding bore 77 in the first housing cover 43 and which issues into the pump chamber 7 at the height of the end face of the rotor 51. To assist the further passage of lubricant (oil), the rotor 51 comprises an annular groove 79 in its end face as well as beads in the internal wall surface 53 and alternatively a coaxial through-going bore 81 by way of

which the lubricant reaches the pump chamber 7 from where it returns back into the lubricant circuit of the internal combustion engine by way of the outlet bore 73. This through-going bore 81 is formed in the exemplified embodiment by means of the guideway slots 59, which receive the wings 61 and which penetrate the rotor 51 in an axial direction. Beads are also provided in the wall of the through-going bore 13 for the lubrication of the drive shaft 15.

A pressure limiting valve 83 is fitted into the connection bore 41 between the pressure duct 35 and the return duct 39 to limit the pressure of the fuel delivered by the gear wheel delivery pump 3.

This pressure limiting valve 83 (illustrated in detail in Fig. 5) is connected onto a return line 85 to the storage tank of the internal combustion engine and comprises between the outlets of the pressure duct 35 and the return duct 39 a valve member 87 which is held by a valve spring 89 against a seal 91 formed by a bore step. The valve spring 89 is on the other hand supported by a clamping sleeve 93 and it is possible by way of the position of said clamping sleeve in the connection bore 41 to adjust the initial force of the valve spring 89 and thus the opening pressure of the pressure limiting valve 83. This pressure limiting valve 83 is also used as a pressure regulating valve in order to limit the maximum flow rate continuously by way of the counterpressure which occurs proportionally.

The delivery device according to the invention functions in the following manner.

During the operation of the internal combustion engine the camshaft of the internal combustion engine drives in a rotational manner by means of the elastic coupling on the driving plate 17 of the drive shaft 15 of the delivery device. This rotational movement of the drive shaft 15 is

transmitted to the first gear wheel 25 of the gear wheel delivery pump 23, which first gear wheel in turn drives the second gear wheel which engages therewith. Fuel is drawn out of the storage tank into the intake chamber 29 of the gear wheel pump 3 in a known manner by way of the intake bore 33, wherein the gear wheel pump 3 is also able to draw in and deliver air so that the said gear wheel pump can be "vented" independently in the event of the fuel lines being discharged of fuel. This fuel is then delivered by way of a said (intake chamber) between the meshing end faces of the gear wheels, into the pressure chamber 31 from where the fuel flows by way of the pressure duct 35 to the pressure bore 45 and further to the internal combustion engine or to a high pressure injection pump provided thereon.

The pressure of the fuel being delivered is limited by means of the pressure limiting valve 83, which is fitted in the connection bore 41 which opens above a predetermined pressure in the pressure duct 35 so that the fuel can flow away into the return line 85. This return line 85 also serves to return the fuel which is not required to the internal combustion engine for which purpose a return line of the internal combustion engine issues into the return duct 39 of the delivery device. The said return duct is continuously connected with the return line 85 to the storage tank by way of the connection bore 41.

The rotor 51 of the vane pump 5 which rotor being rotationally driven by way of the coupling disc 55 intakes air from the brake servo by way of the connecting piece 69 during circulation of said rotor in the pump chamber 7, for which purpose the volume of the individual chambers limited by means of the wings 61 is increased during the rotational movement of the rotor 51 from the outlet of the connection bore 67, so that a vacuum is produced in a known manner. As the rotational

movement continues further after the respective chamber has emerged out of the overlap with the connection bore 67 the volume of the chamber reduces so that the enclosed air volume is delivered under pressure together with the lubricant which flows through the pump chamber 7 into the outlet bore 73 from which this mixture is again supplied to the lubricant circuit of the internal combustion engine.

In this way the non-return valve 71 avoids a return flow of air to the brake servo in particular after switching off the internal combustion engine.

It is thus possible with the delivery device according to the invention to dispose the previously separate assemblies for the delivery of fuel and creation of the vacuum in a structurally convenient manner in a common housing and to drive both assemblies by way of a common drive shaft which considerably reduces manufacturing costs and the required installation space.

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CLAIMS

1. Device for the delivery of fuel from a storage tank to an internal combustion engine of a motor vehicle comprising a delivery pump fitted in a delivery line from the storage tank to the internal combustion engine, which device comprises in its housing at least one pump chamber having rotationally driven positive-displacement elements in particular a gear wheel pump which deliver fuel from an intake chamber connectable to the storage tank into a pressure chamber which can be connected at least indirectly to the internal combustion engine, characterised in that the delivery pump together with a pump which delivers air forms one structural unit whose intake side is connected to a brake servo of the motor vehicle for the purpose of producing a vacuum.

2. Device according to claim 1, characterised in that the delivery pump and the pump which delivers air are disposed coaxially next to one another in a common housing and are driven in a rotational manner by a common drive shaft.

3. Device according to claim 2, characterised in that the pump which delivers air and which is fitted in the common housing of the delivery pump is designed as a vane pump having a rotationally drive rotor mounted in the housing in which guideway slots are provided for the reception of a plurality of wings, whose axially outward pointing ends slide in a sealing manner on the wall of a pump chamber of the vane pump, which pump chamber is disposed in an eccentric manner with respect to the rotor axle.

4. Device according to claim 3, characterised in that the delivery pump which is designed as a gear wheel delivery pump and the vane pump are disposed axially in series and in that the driven gear wheel of the

delivery pump and the rotor of the vane pump are driven in a rotational manner by the common drive shaft.

5. Device according to claim 4, characterised in that the common drive shaft is connected to an axial end of a camshaft of the internal combustion engine by means of an elastic coupling member.

6. Device according to claim 5, characterised in that the elastic coupling member is formed by at least one feather key, made from elastic material, which in each case protrudes into a groove provided on the end face of the camshaft and the end face of a driving plate which is pressed onto the drive shaft.

7. Device according to claim 6, characterised in that pressed on the end of the drive shaft remote from the coupling member towards the camshaft is a coupling disc which is connected in a positive manner to the rotor of the vane pump.

8. Device according to claim 4, characterised in that a cylindrical housing cross-piece is provided in the pump housing on whose peripheral surface the rotor of the vane pump is guided in a sliding manner and in which a through-going bore is disposed coaxially to the rotor in which through-going bore the drive shaft is guided in a sliding manner.

9. Device according to claim 3, characterised in that the radially displaceable wings of the vane pump are disposed in a tilted manner in the direction of rotation of the rotor from its radial plane.

10. Device according to claim 3, characterised in that a connection bore which receives a connection piece for a hose connection to the brake servo issues into the pump chamber of the vane pump and that a non-return valve opening in the direction of the pump chamber is connected in series to the connection piece.

11. Device according to claim 3, characterised in that a lubrication hole which is provided in an inclined manner in the pump housing and connected to the lubricant circuit of the internal combustion engine issues at the end face of the rotor facing the camshaft wherein in the region of this outlet an annular groove is disposed in the end face of the rotor from which beads in the radial inner wall surface and/or a coaxial through-going bore in the rotor lead off to the end face of the pump housing remote from the camshaft, and with a lubricant exit bore which leads off therefrom and which is connected to the lubricant circuit of the internal combustion engine.

12. Device according to claim 4, characterised in that the driven gear wheel of the gear wheel delivery pump is connected in a positive manner to the drive shaft.

13. Device according to claim 4, characterised in that a return duct, which is connected to the return line of the internal combustion engine, and a pressure duct which is in the pump housing and leads from the pressure chamber of the pump chamber of the gear wheel pump is designed as a bead on a housing end face.

14. Device according to claims 7 and 13, characterised in that the pump housing is sealed on its end faces disposed vertically to the axis of the drive shaft in each case by means of a housing cover, wherein a first housing cover, which seals the pump housing on the side facing the camshaft, seals the pump chamber of the gear wheel delivery pump as well as the return duct and pressure duct and a second housing cover which seals the pump housing on the side remote from the camshaft, seals the pump chamber of the vane pump.

15. Device according to claims 7 and 14, characterised in that the

coupling disc lies flat against the second housing cover.

16. Device according to claims 13 and 14, characterised in that the first housing cover are provided a return bore, which leads from the internal combustion engine and issues into the return duct, and a pressure bore, which issues into the pressure duct, and against the said bores on the end face of the first housing cover remote from the pump housing lie in a leasing manner the respective connection bores in the cylinder head of the internal combustion engine.

17. Device according to claim 16, characterised in that a connection duct, which is connected by a return line to the storage tank, is disposed between the return duct and the pressure duct in the pump housing and in said connection duct a pressure limiting valve is fitted which controls the connection between pressue duct and the return duct which is continuously connected to the return line.

18. Device according to claim 14, characterised in that the pump chamber of the gear wheel delivery pump is sealed with respect to the vane pump and the internal combustion engine by means of two shaft seal rings disposed on the drive shaft.

19. Device according to claim 1, characterised in that the gear wheel delivery pump delivers fuel to a high pressure injection pump of the internal combustion engine.

20. Device according to claim 4, characterised in that a restriction point is provided in a fuel supply line which issues into the pump chamber of the delivery pump.

21. Device according to claim 18, characterised in that the shaft seal rings which separate the media of fuel and lubricant are connected to the pump chamber of the delivery pump by means of grooves in such a

manner that a pressure gradient occurs in the direction of the pump chamber.

22. A device constructed and adapted to operate substantially as hereinbefore described with reference to, and as illustrated, in the accompanying drawings.

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The Patent Office

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Application No: GB 9720903.5 **Examiner:** C J Duff
Claims searched: 1 - 22 **Date of search:** 23 January 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): F1F(FAA, FEW)

Int Cl (Ed.6): F04C 11/00, 13/00, 23/00, 25/00, 25/02

Other: On-line: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2064654 A	(NISSAN) See Fig 1	1
A	GB 2026612 A	(BARMAG) Whole document	1
A	GB 0809445 A	(HERAEUS) Whole document	1
A	GB 0809443 A	(HERAEUS) Whole document	1
A	EP 0140506 A2	(GENERAL MOTORS) Whole document	1
A	US 4388893	(APFEL) See column 4, line 60 to column 5, line 4	1

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.

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TITLE: Positive displacement fuel delivery pump combined with vacuum pump
PUBN-DATE: April 1, 1998

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APPL-NO: GB09720903
APPL-DATE: March 29, 1996

PRIORITY-DATA: DE19513822A (April 12, 1995) , GB09606759A (March 29, 1996)

INT-CL (IPC): F04C011/00

EUR-CL (EPC): F04C011/00 , F02M037/14